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CHALLENGES AND APPROACHES TO THE MODELING AND SIMULATION OF GARGANTUAN DISCRETE SYSTEMS

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ABSTRACT

One of the most impactful ways that simulation is used in the physical sciences is to apply relatively simple rules to really large data states, e.g., to simulate the evolution of star position and mass in galaxies, or to track the interaction of many molecules in simulations supporting drug design. When data sets become very very large the computations are organized to execute on specialized computing hardware, and models that operate on domain-specific abstractions of the data are developed. Modeling and simulation can (and is) being used in very large discrete systems (e.g., logical behavior of computer chips) and, philosophically, very large models can be simulated using specialized hardware, specialized data abstractions, and specialized algorithms applied to them. However there are important differences between these and physical models, due to the fact that the foundational rules of discrete models are often complex whereas the foundational rules for physical systems are comparatively simpler physical laws. This talk outlines some of the challenges I've faced in modeling and simulating of gargantuan discrete models, and application domains that give rise to them such as the global Internet, cyber-security of critical infrastructures, and risk assessment of cyber-physical systems.

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DAVID NICOL is the Herman M. Dieckamp Endowed Chair in Engineering at the University of Illinois at Urbana-Champaign, and a member of the Department of Electrical and Computer Engineering. He also serves as the Director of the Information Trust Institute (iti.illinois.edu), and the Director of the Advanced Digital Sciences Center (Singapore). He is PI for two national centers for infrastructure resilience: the DHS-funded Critical Infrastructure Resilience Institute (ciri.illinois.edu), and the DoE funded Cyber Resilient Energy Delivery Consortium (cred-c.org); he is also PI for the Boeing Trusted Software Center, and co-PI for the NSA-funded Science of Security lablet. Prior to joining UIUC in 2003 he served on the faculties of the computer science departments at Dartmouth College (1996-2003), and before that the College of William and Mary (1987-1996). He has won recognition for excellence in teaching at all three universities. His research interests include trust analysis of networks and software, analytic modeling, and parallelized discrete-event simulation, research which has led to the founding of startup company Network Perception, and election as Fellow of the IEEE and Fellow of the ACM. He is the inaugural recipient of the ACM SIGSIM Outstanding Contributions award, and co-author of the widely used undergraduate textbook "Discrete-Event Systems Simulation". His email address isdmnicol@illinois.edu. His website is https://ece.illinois.edu/about/directory/faculty/dmnicol.